CLAIMS

We Claim:

1. A method of catalyzing an enantioselective oxidation reaction of an organic compound, comprising:

    a) contacting the organic compound with:

        i) an oxidizing agent, and

        ii) a catalyst comprising a metal composition and a chiral ligand, wherein the metal is selected from the group consisting of Group 8, Group 9 and Group 10 of the Periodic Table of the Elements; and

    b) producing an oxidized organic compound and a single enantiomer of the organic compound.

2. The method of Claim 1 wherein the organic compound is selected from the group consisting of alcohols, thiols, amines and phosphines.

3. The method of Claim 1 wherein the oxidizing agent is selected from the group consisting of molecular oxygen, benzoquinone, Cu (I) salts, and Cu (II) salts.

4. The method of Claim 3 wherein the oxidizing agent is molecular oxygen.

5. The method of Claim 1 wherein the oxidizing agent is used in a stoichiometric amount.

6. The method of Claim 1 which is conducted in an organic solvent selected from the group consisting of toluene, *tert*-amyl alcohol, water, $CHCl_3$, methylene chloride, 1,2-dichloroethane, and benzene.

7. The method of Claim 1 wherein the metal is palladium.

8. The method of Claim 7 wherein the metal composition is a palladium (II) complex.

9. The method of Claim 8 wherein the palladium (II) complex is selected from the group consisting of $Pd(OAc)_2$, Pd_2(dibenzylideneacetone)$_3$, $PdCl_2$, $Pd(CH_3CN_2)Cl_2$, $Pd(PhCN_2)Cl_2$, $[(allyl)PdCl]_2$, $PdCl_2$ (cyclooctadiene), $Pd(OCOCF_3)$, and Pd(norbornadiene)Cl_2.

10. The method of Claim 1 wherein the chiral ligand is (-)-sparteine.

11. The method of Claim 1 where the percentage of enantiomer that consists of the single enantiomer is at least about 50%.

12. The method of Claim 11 where the percentage of enantiomer is greater than 60%.

13. The method of Claim 12 where the percentage of enantiomer is greater than 90%.

14. The method of Claim 1 wherein the enantioselective oxidation reaction is the kinetic resolution of a racemic mixture.

15. The method of Claim 14 wherein the enantioselective oxidation reaction is the kinetic resolution of racemic alcohols.

16. The organic compound of Claim 15 wherein the organic compound is an alcohol with an oxidizable, secondary functional group.

17. The organic compound of Claim 16 which is a chiral secondary alcohol.

18. The method of Claim 1 wherein the enantioselective oxidation reaction is an enantioselective Wacker-type cyclization reaction.

19. The method of Claim 1 wherein the enantioselective oxidation reaction is an enantioselective aromatic oxidation reaction.

20. The method of Claim 1 wherein the enantioselective oxidation reaction is the enantio-group differentiation of meso diols.

21. The method of Claim 1 wherein the enantioselective oxidation reaction is an enantioselective oxidative [*4+2*] cycloaddition reaction.

22. The method of Claim 1 wherein the enantioselective oxidation reaction is a C-C bond forming cyclization reaction.

23. The method of Claim 1 wherein the enantioselective oxidation reaction is a cyclization reaction.

24. The method of Claim 23 wherein the organic compound contains an olefin tethered to a nucleophilic atom.

25. A catalyst system comprising:

a) a metal composition, wherein the metal is selected from the group consisting of Group 8, Group 9 and Group 10 of the Periodic Table of the Elements; and

b) a chiral ligand comprising:

i) at least one chiral atom, and

ii) two or more tertiary amines that are separated by two or more linking atoms.

26. The catalyst system of Claim 25 wherein the chiral ligand is (-)-sparteine.

27. The catalyst system of Claim 25 wherein the metal is palladium.

28. The catalyst system of Claim 25 wherein the metal composition is a palladium (II) complex.

29. The catalyst system of Claim 28 wherein the palladium (II) complex is selected from the group consisting of $Pd(OAc)_2$, $Pd_2(dba)_3$, $PdCl_2$, $Pd(CH_3CN_2)Cl_2$, $Pd(PhCN_2)Cl_2$, $[(allyl)PdCl]_2$ and $Pd(norbornadiene)Cl_2$.

30. A catalyst system comprising:

a) a chiral ligand having the structure:

$$R^aR^aN\text{-}CR^bR^b\text{-}(X)_n\text{-}CR^bR^b\text{-}NR^aR^a$$

wherein:

each R^a group is independently selected from the group consisting of alkyl, cycloalkyl, cycloheteroalkyl, aryl, heteroaryl and silyl;

X is $-CR^bR^b-$ or a heteroatom;

n is an integer from 0-2; and

each R^b group is independently selected from the group consisting of hydrogen, alkyl, cycloalkyl, cycloheteroalkyl, aryl, heteroaryl and silyl; and

wherein two or more of the R^a and R^b groups, together with the atoms to which they are attached, can be taken together to form one or more cyclic structures;

complexed with

b) a metal composition, wherein the metal is selected from the group consisting of Group 8, Group 9 and Group 10 of the Periodic Table of the Elements.

31. The catalyst system of Claim 30 wherein n is 1.

32. The catalyst system of Claim 31 wherein two or more of the R^a and R^b groups, together with the atoms to which they are attached, are taken together to form a four-ring structure.

33. The catalyst system of Claim 32 wherein the chiral ligand is (-)-sparteine.

34. The catalyst system of Claim 30 wherein the metal is palladium.

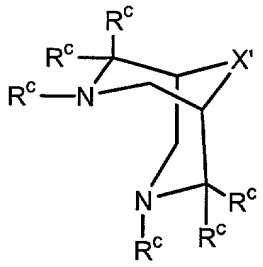
35. The catalyst system of Claim 30 wherein the metal composition is a palladium (II) complex.

36. The catalyst system of Claim 35 wherein the palladium (II) complex is selected from the

group consisting of $Pd(OAc)_2$, $Pd_2(dibenzylideneacetone)_3$, $PdCl_2$, $Pd(CH_3CN_2)Cl_2$, $Pd(PhCN_2)Cl_2$, $[(allyl)PdCl]_2$, $PdCl_2$ (cyclooctadiene), $Pd(OCOCF_3)$, and $Pd(norbornadiene)Cl_2$.

37. A catalyst system comprising:

a) a chiral ligand having the structure:



wherein each R^c group is independently selected from the group consisting of alkyl, cycloalkyl, cycloheteroalkyl, aryl, heteroaryl and silyl; X' is selected from the group consisting of -O-, -S-, $-N(R^d)-$, $-C(R^d)_2-$, -C(O)-, $-C(NR^d)-$, $-C(OR^d)_2-$, and $-C(SR^d)_2-$; and each R^d group is independently selected from the group consisting of hydrogen, alkyl, cycloalkyl, cycloheteroalkyl, aryl, heteroaryl and silyl; and wherein two or more of the R^c and R^d groups, together with the atoms to which they are attached, can be taken together to form one or more cyclic structures; complexed with

b) a metal composition, wherein the metal is selected from the group consisting of Group 8, Group 9 and Group 10 of the Periodic Table of the Elements.

38. The catalyst system of Claim 37 wherein X' is $-CR^dR^d$, and two or more of the R^c and R^d groups, together with the atoms to which they are attached, are taken together to form a four-ring structure.

39. The catalyst system of Claim 38 wherein the chiral ligand is (-)-sparteine.

40. The catalyst system of Claim 37 wherein the metal is palladium.

41. The catalyst system of Claim 37 wherein the metal composition is a palladium (II) complex.

42. The catalyst system of Claim 41 wherein the palladium (II) complex is selected from the group consisting of $Pd(OAc)_2$, $Pd_2(dibenzylideneacetone)_3$, $PdCl_2$, $Pd(CH_3CN_2)Cl_2$,

$Pd(PhCN_2)Cl_2$, $[(allyl)PdCl]_2$, $PdCl_2$ (cyclooctadiene), $Pd(OCOCF_3)$, and $Pd(norbornadiene)Cl_2$.